

Supporting information (SI):

Pollution Profiles, Source Identification and Health Risk Assessment of Heavy Metals in Soil Near a Non-Ferrous Metal Smelting Plant

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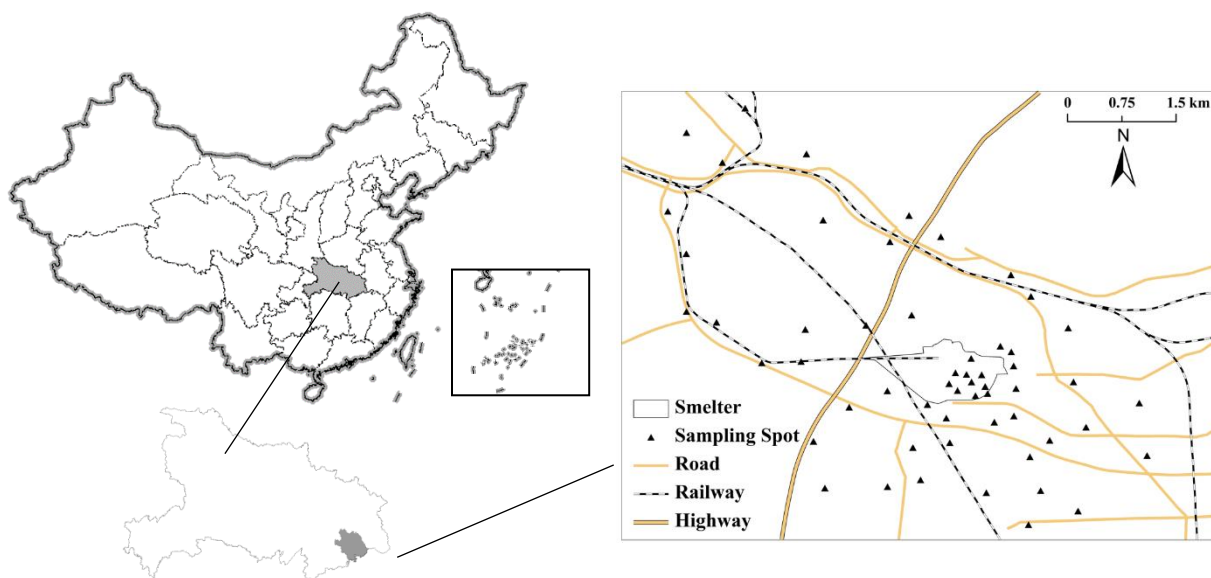


Figure S1. Map of the studied area and location of soil sampling sites (n = 56).

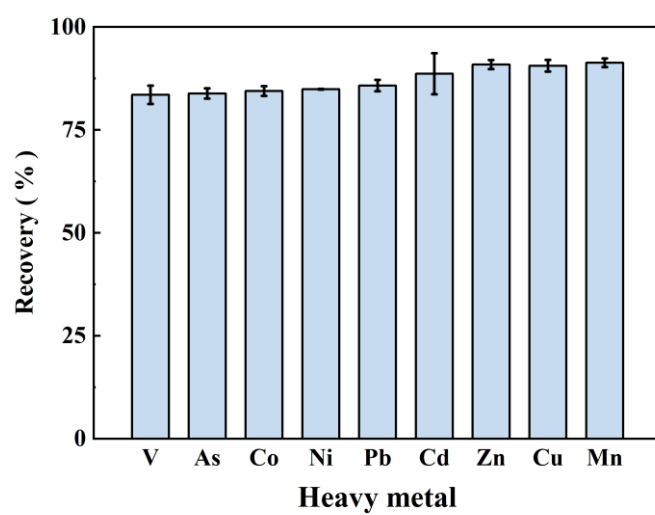


Figure S2. The recovery rates of heavy metal in the standard sample.

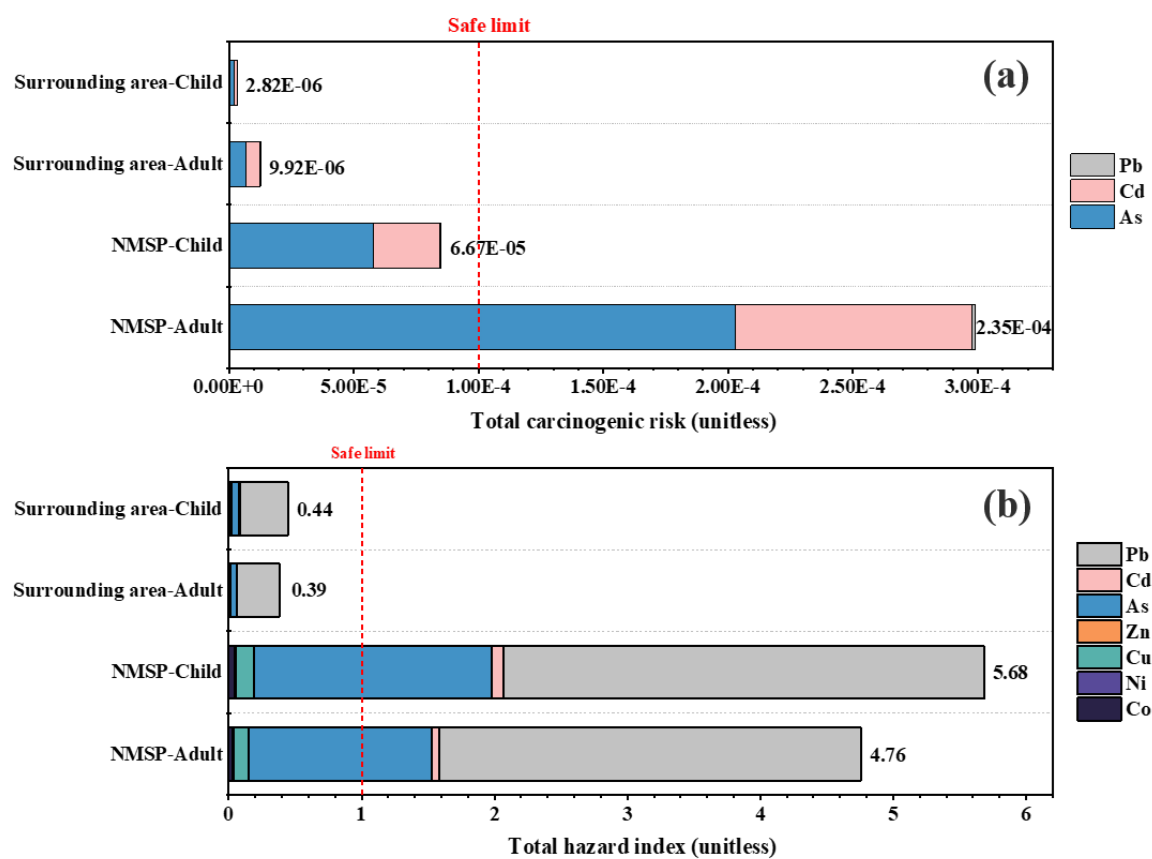


Figure S3. Health risk assessment for soil of surrounding area and non-ferrous metal smelting plant (NMSP): (a) cancer risk and (b) non-cancer risk.

Table S1 Microwave digestion reference procedure [1].

Step	Heating-up time (min)	Target temperature (°C)	Retention time (min)
1	5	120	2
2	4	150	5
3	5	185	40

Table S2 Classification of geoaccumulation index (I_{geo}) and Enrichment factor (EF).

Index	Value	Degree	Reference
Geoaccumulation index	$I_{\text{geo}} \leq 0$	uncontaminated	[2]
	$0 < I_{\text{geo}} \leq 1$	uncontaminated to moderately contaminated	
	$1 < I_{\text{geo}} \leq 2$	moderately contaminated	
	$2 < I_{\text{geo}} \leq 3$	moderately to heavily contaminated	
	$3 < I_{\text{geo}} \leq 4$	heavily contaminated	
	$4 < I_{\text{geo}} \leq 5$	heavily to extremely contaminated	
	$I_{\text{geo}} > 5$	extremely contaminated	
Enrichment factor	$EF < 2$	minimal enrichment	[3]
	$2 \leq EF < 5$	moderate enrichment	
	$5 \leq EF < 20$	significant enrichment	
	$20 \leq EF < 40$	very high enrichment	
	$EF \geq 40$	extremely high enrichment	

Table S3 Parameter meaning and selected value of the average daily intake of heavy metals in soil.

Parameters	Parameter meaning	Unit	Children	Adult
<i>ED</i>	Exposure duration	year	6 ^a	24 ^a
<i>BW</i>	Body weight	kg	26.3 ^b	60.1 ^c
<i>IR</i>	Daily inhalation rate	m ³ /day	10.2	15.8
<i>SAE</i>	Skin surface area	cm ²	9800	16000
<i>SER</i>	Skin exposure ration	-	0.36	0.32
<i>Cs</i>	Concentrations of potential toxic elements	mg/kg		
<i>IRs</i>	ingestion rate of soil	mg/d	50 ^a	
<i>CF</i>	Conversion factor of concentrations	kg/mg	1.00E-06 ^a	
<i>FI</i>	Oral absorption of soil absorption factors	-	1 ^a	
<i>EF</i>	Exposure frequency	day/year	350 ^a	
<i>PEF</i>	Particulate emission factor	m ³ /kg	1.36 × 10 ⁹ ^a	
<i>AF</i>	Dermal adherence factor	-	0.2 ^a	
<i>ABS_d</i>	Dermal absorption factor	-	As (0.03) ^a Others (0.001) ^a	
<i>RfDi</i>	The reference dose	mg/kg/d		
<i>RfC</i>	Respiratory inhalation reference concentration	mg/m ³		
<i>GIABS</i>	Digestive tract absorption efficiency factor	-	Table S3	
<i>SF</i>	Carcinogenic slope factor	mg/kg/d		
<i>IUR</i>	Respiratory inhalation unit carcinogen	m ³ /kg		

^a [4], ^b [5], ^c [6], ^d [7]

Table S4 Parameters for non-cancer risk and cancer risk assessment.

Elements	IUR	RfD _o	RfC	RfD _i (mg/m ³)		RfD _d	GIABS	SF _o	SF _i		SF _d
	(µg/m ³) ⁻¹	(mg/kg-day)	(mg/kg-day)	adult	child	(mg/kg-day)		(mg/kg-day) ⁻¹	adult	child	
V	8.30E-03 ^a	9.00E-03 ^a	7.00E-06 ^a	1.69E-06	2.00E-06	2.34E-04	2.60E-02 ^a	n/a	34.40	29.11	n/a
Mn	n/a	1.40E-01 ^a	5.00E-05 ^a	1.21E-05	1.43E-05	1.40E-01	1.00E+00 ^a	n/a	n/a	n/a	n/a
Co	9.00E-03 ^a	3.00E-04 ^a	6.00E-06 ^a	1.45E-06	1.71E-06	3.00E-04	1.00E+00 ^a	n/a	37.30	31.56	n/a
Ni	2.60E-03 ^a	2.00E-02 ^a	9.00E-05 ^a	2.17E-05	2.57E-05	8.00E-04	4.00E-02 ^a	n/a	10.78	9.12	n/a
Cu	n/a	4.00E-02 ^a	n/a	n/a	n/a	4.00E-02	1.00E+00 ^a	n/a	n/a	n/a	n/a
Zn	n/a	3.00E-01 ^a	n/a	n/a	n/a	3.00E-01	1.00E+00 ^a	n/a	n/a	n/a	n/a
As	4.30E-03 ^a	3.00E-04 ^a	1.50E-05 ^a	3.62E-06	4.28E-06	3.00E-04	1.00E+00 ^a	1.50E+00 ^a	17.82	15.08	1.50E+00
Cd	1.80E-03 ^a	1.00E-04 ^a	1.00E-05 ^a	2.41E-06	2.85E-06	2.50E-06	2.50E-02 ^a	6.10E+00 ^b	7.46	6.31	2.44E+02
Pb	1.20E-05 ^a	3.50E-03 ^b	n/a	n/a	n/a	3.50E-03	1.00E+00 ^a	8.50E-03 ^a	0.05	0.04	8.50E-03

n/a, data not available. ^a[8]; ^b[9].

Table S5 The concentrations of heavy metals in the control area (mg/kg).

Sample	V	Mn	Co	Ni	Cu	Zn	As	Cd	Pb
1	23.78	114.30	2.06	7.13	6.44	53.74	12.19	n/a	79.06
2	51.41	763.49	14.20	13.67	72.18	67.76	11.51	0.21	26.09
Mean	37.60	438.90	8.13	10.40	39.31	60.75	11.85	0.21	52.58

n/a, data was below the LOD

Table S6 Summary of the risk screening standards levels (mg/kg) for heavy metals under investigation.

Category	V	Mn	Co	Ni	Cu	Zn	As	Cd	Pb
Chinese standard for agricultural soil ^a	n/a	n/a	n/a	70.00	50.00	200.00	30.00	0.40	100.00
Chinese standard for industrial soil ^b	165.00	n/a	70.00	900.00	18000.00	n/a	60.00	65.00	800.00

n/a, data not available. ^a [10] ^b [11]

Table S7 The median concentrations of heavy metals in investigations of other countries.

	V	Mn	Co	Ni	Cu	Zn	As	Cd	Pb	Reference
Surrounding area in this study	20.32	634.84	14.38	20.02	264.96	196.30	28.44	2.06	74.62	-
Bulgarian	n/a	n/a	8.00	17.00	1449.77	202.00	100.00	1.20	78.67	[12]
Legnica (Southwest Poland)	24	235	6.2	10.4	81	98	n/a	0.25	79	[13]

n/a, data not available

Table S8 The exposure level of the adults and children in the surrounding area and non-ferrous metal smelting plant (NMSP) for non- cancer risks assessment.

Element	ADD _{s-oral}		ADD _{s-inh}		ADD _{s-dermal}		ADD _s	
	adult	child	adult	child	adult	child	adult	child
Surrounding area								
Co	2.91E-06	3.31E-06	6.75E-10	7.55E-09	1.79E-10	1.40E-10	2.91E-06	3.32E-06
Ni	3.70E-06	4.21E-06	8.59E-10	9.60E-09	2.27E-10	1.78E-10	3.70E-06	4.22E-06
Cu	8.56E-05	9.75E-05	1.99E-08	2.22E-07	5.26E-09	4.13E-09	8.57E-05	9.77E-05
Zn	8.91E-05	1.01E-04	5.47E-09	4.29E-09	2.07E-08	2.31E-07	8.91E-05	1.02E-04
As	1.36E-05	1.54E-05	3.15E-09	3.52E-08	8.33E-10	6.53E-10	1.36E-05	1.55E-05
Cd	2.84E-06	3.24E-06	6.61E-10	7.39E-09	1.75E-10	1.37E-10	2.85E-06	3.25E-06
Pb	4.46E-05	5.07E-05	1.04E-08	1.16E-07	2.15E-09	2.74E-09	4.46E-05	5.08E-05
NMSP								
Co	8.86E-06	1.01E-05	2.06E-09	2.30E-08	5.45E-10	4.27E-10	8.86E-06	1.01E-05
Ni	5.04E-05	5.74E-05	1.17E-08	1.31E-07	3.10E-09	2.43E-09	5.05E-05	5.76E-05
Cu	4.64E-03	5.29E-03	1.08E-06	1.21E-05	2.85E-07	2.24E-07	4.64E-03	5.30E-03
Zn	7.03E-04	8.00E-04	4.32E-08	3.39E-08	1.63E-07	1.83E-06	7.03E-04	8.02E-04
As	4.06E-04	4.62E-04	9.43E-08	1.05E-06	2.49E-08	1.96E-08	4.06E-04	4.63E-04
Cd	4.64E-05	5.29E-05	1.08E-08	1.21E-07	2.85E-09	2.24E-09	4.65E-05	5.30E-05
Pb	4.44E-04	5.06E-04	1.03E-07	1.15E-06	2.14E-08	2.73E-08	4.45E-04	5.07E-04

Table S9 The exposure level of the adults and children in the surrounding area and non-ferrous metal smelting plant (NMSP) for cancer risks assessment.

Element	ADD _{s-oral}		ADD _{s-inh}		ADD _{s-dermal}		ADD _s	
	adult	child	adult	child	adult	child	adult	child
Surrounding area								
As	4.52E-06	1.29E-06	1.05E-09	1.93E-10	2.78E-10	5.44E-11	4.52E-06	1.29E-06
Cd	9.48E-07	2.70E-07	2.20E-10	4.05E-11	5.83E-11	1.14E-11	9.49E-07	2.70E-07
Pb	1.49E-05	4.23E-06	9.13E-10	1.79E-10	3.45E-09	6.34E-10	1.49E-05	4.23E-06
NMSP								
As	1.35E-04	3.85E-05	3.14E-08	5.77E-09	8.31E-09	1.63E-09	1.35E-04	3.85E-05
Cd	1.55E-05	4.41E-06	3.60E-09	6.61E-10	9.51E-10	1.86E-10	1.55E-05	4.41E-06
Pb	1.48E-04	4.22E-05	9.10E-09	1.78E-09	3.44E-08	6.32E-09	1.48E-04	4.22E-05

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